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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 1.043.008 WO	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)	
International application No. PCT/NL 03/00879	International filing date (day/month/year) 11.12.2003	Priority date (day/month/year) 10.01.2003
International Patent Classification (IPC) or both national classification and IPC F24H1/00		
Applicant FERRO TECHNIEK HOLDING B.V.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
- ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).
- These annexes consist of a total of 10 sheets.

3. This report contains indications relating to the following items:
- I ☒ Basis of the opinion
 - II ☐ Priority
 - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
 - IV ☐ Lack of unity of invention
 - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
 - VI ☐ Certain documents cited
 - VII ☐ Certain defects in the international application
 - VIII ☐ Certain observations on the international application

Date of submission of the demand 19.07.2004	Date of completion of this report 10.05.2005
Name and mailing address of the international preliminary examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Van Gestel, H Telephone No. +31 70 340-3155 

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/NL 03/00879

1. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, Pages

1-8 received on 23.12.2004 with letter of 22.12.2004

Claims, Numbers

1-13 received on 07.03.2005 with letter of 04.03.2005

Drawings, Sheets

1/1 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

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5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-13
	No: Claims	
Inventive step (IS)	Yes: Claims	
	No: Claims	1-13
Industrial applicability (IA)	Yes: Claims	1-13
	No: Claims	

2. Citations and explanations

see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/NL 03/00879

Re Item V

**Reasoned statement with regard to novelty, inventive step or industrial applicability;
citations and explanations supporting such statement**

Reference is made to the following documents:

D1: US-A-4 803 343 (MASHINO NOBUYOSHI ET AL) 7 February 1989 (1989-02-07)

D2: US-A-3 934 643 (LAING) JANUARY 27 1976

The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1 does not involve an inventive step in the sense of Article 33(3) PCT.

The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and discloses (the references in parentheses applying to this document):
Device for heating liquids, comprising a first liquid container (9) for liquid for heating, a second liquid container (1), which second liquid container (1) is at least partially filled with an intermediary liquid, and a heating element (4) coupled to the second container and wherein heat transfer from the heating element to the liquid for heating takes place at least substantially via the intermediary liquid, and wherein the intermediary liquid is formed at least substantially by water.

The subject-matter of claim 1 therefore differs from this known heating device in that the pressure in the second liquid container below atmospheric at room temperature.

The problem to be solved by the present invention may therefore be regarded as to improve the heat transfer.

The solution proposed in claim 1 of the present application cannot be considered as involving an inventive step (Article 33(3) PCT) for the following reasons.

The working conditions in a heat pipe construction are defined by the fluid and the pressure in the closed system. Choosing the fluid and the pressure in the system involves no inventive step for a person skilled in the art. Choosing a fluid under conditions such, that at room temperature the pressure is below atmospheric, is known, see document D2, col 2 lines 15-29.

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/NL 03/00879

Dependent claims 2-13 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step, the reasons being as follows:

The subject-matter of these claims is disclosed in document D1.

Device for heating liquids and assembly for use in such a device**23.12.2004****(77)**

The invention relates to a device for heating liquids, comprising a first liquid container for liquid for heating, a second liquid container, which second liquid container is at least partially filled with an intermediary liquid, and a heating element coupled to the second liquid container, wherein heat transfer from the heating element to the liquid for heating takes place at least substantially via the intermediary liquid. . The invention also relates to an assembly for use in such a device.

Devices for heating liquids have been known for a long time. The applications of these devices can also be very diverse in nature. Such heating devices are thus already applied for instance as, or as component, in water kettles, dish washers, washing machines, coffee-making machines and the like. A known drawback of the known devices which are (partially) adapted to heat liquids is the deposition of contaminants, such as limescale and soap residues and the like, on the heating element. The heat transfer from the heating element to the liquid for heating is considerably impeded by the deposition of contaminants on the heating element. Heating of the liquid to a desired temperature will therefore generally require more time and energy, which is costly and may be accompanied by overheating of the heating element.

An improved heating device is disclosed in the United States Patent US 4,803,343, comprising a container for a liquid to be heated, an elongated receiver partially filled with a working fluid, and a heating element substantially positioned within said receiver. During operation, the heating element will evaporate the working fluid to vapour bubbles which bubbles will subsequently condense at a wall of the receiver, thereby generating condensation heat for heating the liquid. Heating of the liquid for heating via the working fluid has the substantial advantage that the heating element per se remains substantially unaffected, since direct physical contact between the heating element and the liquid for heating is prevented. However, heating a liquid by means of this device has as major drawback to pass off relatively slowly, wherein a considerable amount of energy is required to initiate (sufficient) bubble formation to heat the liquid to a desired temperature.

The invention has for its object to provide an improved heating device with which a liquid can be heated in a relatively quick and energy-saving manner.

The invention provides for this purpose a device of the type stated in the preamble, characterized in that an underpressure is present in the second liquid container at room temperature. By applying an underpressure in the second container at room temperature, the boiling point of the intermediary liquid is reduced and thus enhances vapour bubble formation, and therefore also the heat transfer. In this manner liquids can be heated in a relatively quick and energy-saving manner. As mentioned afore heating of the liquid for heating via the intermediary liquid has the substantial advantage that the heating element per se remains substantially unaffected, since direct physical contact between the heating element and the liquid for heating is prevented. No deposition on the heating element of components present in the liquid for heating will therefore occur. The fact that the heating element remains unaffected generally has the result that at least a substantial part of the heat produced by the heating element will be transferred to the intermediary liquid. The intermediary liquid will then (partially) evaporate to an intermediary gas fraction formed by vapour bubbles, whereafter the vapour bubbles will then rise via or through the intermediary liquid and subsequently condense at a relatively cool location, i.e. generally at the position of the first liquid container, while generating condensation heat to the liquid for heating. It is noted that the liquid for heating can be of very diverse nature. Water for instance can thus be heated using the device according to the invention, but also oil or other liquids which may or may not be viscous, and dispersions (such as an emulsion or suspension). It is also possible to heat solids, such as food, present in the liquid using the device according to the invention. The heating element will usually only be in contact with the relatively pure intermediary liquid. Direct physical contact between the heating element and the intermediary liquid is not however essential. A relatively good thermal contact is however essential. By applying a heating element which is at least substantially always clean a maximum heat transfer will therefore always be possible from heating element to intermediary liquid. Furthermore, as the heating element remains relatively clean after (frequent) use, the lifespan of a heating element applied according to the invention is generally much greater. It will be possible to only partially fill the second liquid container with the intermediary liquid, and a remaining part of the liquid container will be formed by an intermediary gas, in particular intermediary vapour, corresponding to the intermediary

liquid. During operation of the device the intermediary liquid in the second liquid container is heated by the heating element, whereby evaporation of (a part of) the intermediary liquid will take place. The resulting intermediary vapour will condense against the relatively cool second liquid container and generate condensation heat. The heat absorbed by the second liquid container is then relinquished to the liquid for heating received in the first liquid container. Vapour formation or gas formation in the intermediary liquid thus plays an important part during the heat transfer from the heating element to the liquid for heating. It is noted that the amount of intermediary liquid is preferably sufficient to prevent the heating element boiling dry, also for instance in the case the device is in inclining position. In the case for instance no underpressure is applied in the second liquid container, the intermediary gas (vapour) in equilibrium with the intermediary liquid can also form part of a different gas, such as atmospheric air.

In a preferred embodiment, the second liquid container forms a physical separation between the heating element and the first liquid container. As already noted, the intermediary liquid may or may not be in contact with the heating element. The design of both the heating element and the second liquid container can be very diverse and depends particularly on the application of the device. In a particular preferred embodiment, the heating element is at least substantially enclosed by the second liquid container. This particular preferred embodiment is generally advantageous since (almost) all, or at least a large part, of the heat produced by the heating element can be absorbed by the intermediary liquid, whereby the heat transfer efficiency can be optimized.

The intermediary liquid is preferably formed at least substantially by water, in particular relatively pure water. Since deposition of components present in the intermediary liquid has to be prevented, or at least countered, the intermediary liquid has to be at least substantially free of ions or other dispersed particles which form a precipitate relatively quickly in increased temperature conditions. It is however also possible to envisage the use of other liquids as well as water.

In a preferred embodiment, the second liquid container is at least partially deformable, particularly at a relatively high temperature of the intermediary liquid. Since the second

liquid container generally becomes relatively warm during use of the device, deposition of components present in the liquid for heating, such as limescale, can also take place on the second liquid container. By giving the second liquid container a (slightly) flexible form, precipitate formed on the second liquid container can be loosened by vibration and long-term deposition on the second liquid container can be prevented, or at least countered. Deforming of the second liquid container can for instance be realized by vapour bubbles formed in the intermediary liquid which 'collide' with the second liquid container, whereby it will begin to vibrate. It is however also possible to envisage manufacturing the second liquid container from material which deforms reversibly at transitions in temperature. An additional advantage of causing slight deformation and at least partial vibration of the second liquid container is that vapour bubbles formed in the intermediary liquid can hardly remain 'attached' to the second liquid container. This phenomenon is also referred to as 'vapour lock'. Clinging of the vapour bubbles to the second liquid container generally reduces the heat-transferring capacity of the second liquid container considerably.

In another preferred embodiment the heating element is positioned at a distance from the first liquid container. Such a positioning of the heating element has the advantage that a seal positioned between the heating element and the first liquid container can be arranged at a relatively cool position, and thus at a distance from the heating element. The seal will herein not degenerate, or hardly so, as a result of the only small thermal fluctuations, which generally enhances the lifespan.

In yet another preferred embodiment, the device is provided with a safety provision to prevent overheating of the device. This safety provision can for instance be formed by a temperature sensor in the heating element, a steam sensor or a pressure sensor in the second liquid container. In addition, it is also conceivable to measure the deformation, optionally per unit of time, of the second liquid container as a measure for the temperature prevailing in the intermediary vapour.

The second liquid container is preferably provided at least partially with a profiled surface. By giving the surface of the second liquid container a profiled, in particular ribbed form, the contact surface of the second liquid container with the liquid for

heating is enlarged, whereby the heat absorbed by the second liquid container can be generated more efficiently to the liquid for heating. It is however also possible to envisage providing the second liquid container with one or more protruding parts in order to enlarge the contact surface, and thereby the heat transfer per unit of time, of the
5 second liquid container with respect to the liquid for heating.

The second liquid container preferably takes an at least substantially rod-like form. A rod-like second liquid container generally has the property of being relatively pressure-resistant. A second liquid container of other form can also be applied in addition to a
10 rod-like second liquid container.

In a preferred embodiment the second liquid container is manufactured at least partially from a relatively smooth stainless steel. Deposition on the second liquid container of precipitate from the liquid for heating can be prevented, or at least countered, by
15 applying a second liquid container manufactured from a relatively smooth stainless steel, whereby the heat transfer from the second liquid container to the liquid for heating will not generally be impeded by precipitate. A second liquid container manufactured from smooth stainless steel is moreover usually relatively simple to clean. In addition to stainless steel, it is also conceivable to apply other temperature-resistant materials for
20 manufacture of the second liquid container, which materials are preferably also provided with a surface which prevents, or at least counters, adhesion of solids.

In a preferred embodiment the heating element is connected non-releasably to the second liquid container. The non-releasable connection can for instance be realized by a
25 welded connection. Before the second liquid container is sealed medium-tightly, it is filled, preferably partially, with the intermediary liquid and an underpressure is optionally applied in the second liquid container. In another preferred embodiment however, the second liquid container is connected releasably to the heating element. Such a preferred embodiment makes it possible to replace or clean the intermediary
30 liquid and/or the second liquid container after a determined period of time. Such a preferred embodiment furthermore makes it possible in simple manner to carry out maintenance work on the heating element. A seal is preferably arranged between the second liquid container and the heating element in order to seal the second liquid container medium-tightly. The seal can for instance be formed by a rubber ring.

The invention also relates to an assembly of a heating element and a second liquid container for use in the above stated device. The assembly can then be fitted in a first liquid container to form the device according to the invention.

5

The invention will be elucidated with reference to non-limitative exemplary embodiments shown in the following figures, in which:

figure 1 shows a cross-section of a first embodiment of a water kettle provided with a heating device according to the invention,

10 figure 2 shows a cross-section of a second embodiment of a water kettle provided with a heating device according to the invention, and

figure 3 shows a cross-section of a first embodiment of a dish washer provided with a heating device according to the invention.

15 Figure 1 shows a cross-section of a first embodiment of a water kettle 1 provided with a heating device 2 according to the invention. Water kettle 1 comprises a first liquid container 3 for water for heating 4. Heating device 2 comprises a heating element 5 and a second liquid container 6 provided with an intermediary liquid 7. As shown clearly in figure 1, the second liquid container 6 forms a physical separation between heating
20 element 5 and the water for heating 4 in the first liquid container 3. Heating of water 4 will thus always take place by means of heat transfer from heating element 5 to the water for heating 4 via the second liquid container 6 and the intermediary liquid 7 received therein. In this manner deposition of the components present in the water for heating 4, such as for instance deposition of limescale, on heating element 5 can be
25 prevented. The great advantage hereof is that the capacity (progression) of heating element 5, and thus of water kettle 1, to transfer heat to the water 4 for heating remains at least substantially constant. It is however essential that a relatively pure intermediary liquid 7 is applied, in order to prevent, or at least minimize, deposition of the components present in intermediary liquid 7. The second liquid container 6 is provided
30 with an at least substantially fully closed housing 8, which housing 8 is partially filled with intermediary liquid 7. An intermediary gas fraction 9, in particular a vapour phase of intermediary liquid 7, will therefore always be present above intermediary liquid 7. An underpressure is preferably applied in the second liquid container 6. The advantages of an applied underpressure have already been described above. A variety of liquids,

such as for instance water, alcohol and oil, can be applied as intermediary liquid 7. As will be apparent, the intermediary liquid 7 in the shown embodiment is not in physical contact with heating element 5, but is however in good thermal contact. The intermediary liquid 7 will thus be heated via housing 8 by heating the heating element 5.

5 The relatively warm housing 8 and intermediary liquid 7 then transfer heat (in small measure) to the water for heating 4. With sufficient heating of intermediary liquid 7, vapour bubbles will be formed in intermediary liquid 7 close to heating element 5. The vapour bubbles will subsequently rise and eventually collide with a part of housing 8. Upon this collision the formed vapour bubbles will condense while relinquishing
10 condensation heat to a part of housing 8 in contact with the water for heating 4. The heating of a liquid by means of condensation heat is generally relatively efficient. Housing 8 can be manufactured from diverse materials or from a combination of materials. At least a part of housing 8 in contact with the water for heating 4 preferably takes a slightly thin-walled and flexible form. Precipitate deposited on a side of housing
15 8 remote from the intermediary liquid 7 will generally be removed as a result of vibrations of housing 8 caused by the collision with housing 8 of vapour bubbles from intermediary liquid 7. It is also possible to envisage manufacturing housing 8 from a material with a relatively high coefficient of expansion. As a consequence of temperature change, material deformation (expansion or contraction) of housing 8 will
20 then take place relatively quickly, whereby precipitate deposited on housing 8 will usually also be removed from housing 8 independently. In this manner the heating device 2 thus acquires a kind of self-cleaning capability.

Figure 2 shows a cross-section of a second embodiment of a water kettle 10 provided
25 with a heating device according to the invention. Water kettle 10 comprises a first liquid container 11 for water to be heated 12, and a heating device 13 for heating the water to be heated 12. Heating device 13 is arranged in an opening arranged in the first liquid container 11. For sufficient sealing of this opening the heating device 13 is positioned in the opening with clamping fit and via a sealing ring 14. Heating device 13 comprises a
30 heating element 15 and a boiler 16 connected to heating element 15, which boiler 16 is partially filled with an intermediary liquid 17. Other than in figure 1, the intermediary liquid 17 is now in direct (physical) contact with heating element 15. Boiler 16 takes a substantially conical form and is preferably manufactured from a material which allows reversible deformation during temperature fluctuations. Examples of such materials can

be for instance plastic or metal. Deformation of boiler 16, or at least a part thereof, during temperature fluctuations prevents deposition of scale (precipitate) on boiler 16 from the water to be heated 12. In the shown embodiment the heating element 15 lies at a distance from the first liquid container 11, which is generally particularly
5 advantageous since the sealing ring 14 is then also positioned at a distance from heating element 15, and thus at a relatively cool location. Sealing ring 14 usually degenerates relatively rapidly with considerable temperature fluctuations, which is now largely prevented. The operation of the water kettle 10 shown in figure 2 corresponds substantially to that of the water kettle 1 shown in figure 1. It will therefore not be
10 described further here.

Figure 3 shows a cross-section of a first embodiment of a dish washer 18 provided with a heating device 19 according to the invention. Heating device 19 is positioned at least substantially wholly in a washing chamber 20 of dish washer 18. Heating device 19
15 comprises an at least substantially cylindrical second liquid container 21 and a heating element 22 positioned at least substantially co-axially in the second liquid container 21. The second liquid container 21 is partially filled with an intermediary liquid 23 and the remaining part is filled with an intermediary gas fraction 24 corresponding with the intermediary liquid 23. A pressure sensor 25 is arranged in intermediary gas fraction 24
20 to prevent overload of heating device 19. Heating element 22 is connected to a voltage supply (not shown). Heating device 19 is adapted such that the second liquid container 21 is connected releasably to heating element 22, so as to enable maintenance operations or replacement of components. Heating element 22 now takes a rod-like form. It is likewise possible to envisage using heating elements of other form, such as
25 for instance spiral-shaped, plate-like and strip-like heating elements. It should be apparent that the heating device according to the invention can be used in numerous applications and can be of very varied design.

Amended Claims

EPO - DG I

07.03.2005

1. Device for heating liquids, comprising:

- a first liquid container for liquid for heating,
- a second liquid container, which second liquid container is at least partially filled with an intermediary liquid, and
- a heating element coupled to the second liquid container,

wherein heat transfer from the heating element to the liquid for heating takes place at least substantially via the intermediary liquid, and wherein the intermediary liquid is formed at least substantially by water,

characterized in that

an underpressure is present in the second liquid container at room temperature.

2. Device as claimed in claim 1, **characterized in that** the second liquid container is at least partially deformable at a relatively high temperature of the intermediary liquid.3. Device as claimed in claim 1 or 2, **characterized in that** the second liquid container forms a physical separation between the heating element and the first liquid container.4. Device as claimed in any of the preceding claims, **characterized in that** the heating element is at least substantially enclosed by the second liquid container.5. Device as claimed in any of the foregoing claims, **characterized in that** the heating element is positioned at a distance from the first liquid container.6. Device as claimed in any of the foregoing claims, **characterized in that** the device is provided with a safety provision to prevent overheating of the device.7. Device as claimed in any of the foregoing claims, **characterized in that** the second liquid container is provided at least partially with a profiled surface.8. Device as claimed in any of the foregoing claims, **characterized in that** the second liquid container takes an at least substantially rod-like form.

9. Device as claimed in any of the foregoing claims, **characterized in that** the second liquid container is manufactured at least partially from a relatively smooth stainless steel.
10. Device as claimed in any of the foregoing claims, **characterized in that** the heating element is connected non-releasably to the second liquid container.
11. Device as claimed in any of the claims 1-9, **characterized in that** the second liquid container is connected releasably to the heating element.
12. Device as claimed in any of the foregoing claims, **characterized in that** a seal is arranged between the second liquid container and the heating element.
13. Assembly of a heating element and a second liquid container for use in a device as claimed in any of the claims 1-12.

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